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DEVICE AND METHOD FOR AUTHORIZATION INTERROGATION IN A MOTOR VEHICLE

~~Related Art~~

The present invention concerns a device and a method for an authorization interrogation in a motor vehicle. ~~The~~ article "Keyless entry system with radio car transponder", by Motoki Hirano, Mikio Takeuchi, Takahisa Tomoda, Kin-Ichiro Nakano, published in the IEEE transactions on industrial electronics, Vol. 35, No. 2, May 1988, pages 208 through 216, describes a keyless entry system. In this system, a transponder ~~A transponder~~ carried by the user executes an access authorization dialog with an antenna arranged in the vehicle. The an access authorization being or not being granted is based on ~~on the basis of~~ the access authorization dialog. The antennas of the vehicle are arranged in the lateral rearview mirror housing and in the rear bumper.

However, this antenna array results in an increased cabling outlay since provision must be made for a data connection to the door controller generally arranged in the passenger compartment. The ~~On the other hand, the~~ accommodation in the exterior mirror allows the external space to be interrogated without greater attenuation of the magnetic field.

The object of the present invention is to conveniently arrange the antenna only in the interior space and, at the same time, to ensure a trouble-free signal exchange with the transponder. The invention is solved by the characterizing features of the independent claims.

Advantages of the Invention

The device according to the present invention for an authorization interrogation in a motor vehicle has a

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transponder which exchanges data with an antenna array within the framework of an authorization interrogation. The antenna array is composed of a left antenna array arranged on the left side of the motor vehicle and of a right antenna array arranged on the right side of the motor vehicle. During an external space interrogation, the left antenna array receives a current for the external space interrogation, the right antenna array receives a current for the external space interrogation. Preferably, the currents of the left and of the right antenna arrays are selected to have different magnitudes, to be different from zero and/or to have current phases are selected to be inverted relative to each other. The antenna arrays are preferably accommodated in the lateral posts behind the right or left side-doors, respectively. Due to the spatial proximity of the antenna array to the vehicle locking system, the cabling outlay can be reduced. The different selection of the current magnitude or of the phases (inverting control) of the left and right antenna arrays contributes to an unequivocal transponder recognition on one of the two (right or left) sides of the motor vehicle. If, for example, the left external space of the motor vehicle is to be interrogated, a correspondingly high current is applied to the left antenna array. The left antenna array ensures the communication with the transponder, which is generally located on the left side. On the contrary, the right antenna array is controlled using a lower current in an inverting manner with respect to the useful signal of the current of the left antenna array. The left antenna array which is radiated by the left antenna array to compensate for the field side, in such a manner that a transponder possibly located on the right side of the vehicle cannot enter into a signal exchange with the base station. In this manner, manipulations can be reduced. Moreover, an unwanted communication of a transponder located on the left side with the right antenna array is prevented as well. Because of the possibility of this active disturbance field compensation, the transmitting power of the antenna which interrogates the desired side area can be

increased. The disadvantageous effects due to the unwanted emergence of the magnetic waves on the opposite vehicle side do not impair the reliability of the authorization interrogation.

~~In an expedient embodiment, provision is made for an antenna~~ provided in the antenna array to be used both for the external space interrogation and for an interior space interrogation. Due to this double use, the required component outlay is reduced. The interior space interrogation can be carried out for a driving authorization interrogation. The control of the left and right antenna arrays can be selected in such a manner that each one covers a half-space of the passenger compartment for transponder communication. For interior space monitoring, the two antenna arrays ~~are preferably~~ controlled successively, ~~in particular, if~~ each of the antenna arrays ~~covers~~ the whole interior space.

In ~~an advantageous~~ embodiment, the antenna array ~~is~~ composed of at least two antennas which are aligned orthogonally relative to each other. In this manner, a rotating magnetic field can be generated so that a signal exchange with a transponder located in any arbitrary position is achieved.

The antenna used both for the interior space interrogation and for the external space interrogation ~~is preferably~~ designed as a ferrite coil. ~~It is also possible to use~~ an air coil. In this manner, the magnetic fields needed for a reliable data exchange can be attained.

~~In a first step, the~~ method according to the present invention for an authorization interrogation in a motor vehicle queries an operating signal. ~~In a second step~~, a current value for controlling an antenna array is selected as a function of the operating signal. ~~In a third step~~, the antenna array is controlled using the selected current value for carrying out the authorization interrogation. ~~The~~ desired interrogation

type, external space interrogation as access authorization, interior space interrogation as driving authorization, can be allocated in a simple manner on the basis of the operating signals.

Further expedient embodiments follow from the further dependent claims and from the description.

Drawing

Two exemplary embodiments of the present invention are depicted in the drawing and will be described in the following in greater detail.

Figure 1 shows a top view of a motor vehicle equipped with the device according to the present invention;

Figures 2 and 3 show block diagrams of two exemplary embodiments;

Figure 4 shows a signal pattern; and

Figure 5 shows a flow chart of the method according to the present invention.

Description of the Exemplary Embodiments

On the left side of a motor vehicle shown in a top view, a left antenna array 10 is accommodated between the left front door and back door. During an external space interrogation of the left external space, left antenna array 10 emits an antenna field 16 for the external space interrogation on the left and an antenna field 14 oriented toward the interior space. Within antenna field 16 for the external space interrogation on the left, a transponder 11 is located which, in this case, exchanges signals with left antenna array 10. Antenna field 14, which is oriented toward the interior space,

reaches beyond the right side of the motor vehicle. The intention is for this field reaching beyond to be equalized by a compensating field 18 for the external space interrogation on the left, generated by a right antenna array 12.

In the exemplary embodiment according to Figure 2, left antenna array 10 is composed of a first left antenna 21 and a second left antenna 22, which are arranged orthogonally relative to each other. First left antenna 21 is controlled by a driver 24 for the first left antenna, second left antenna 22 is controlled by a driver 25 for the second left antenna. Right antenna array 12 is formed of a first right antenna 31 and a second right antenna 32 which, in turn, are arranged orthogonally relative to each other, together with the appertaining driver 34 for the first antenna on the right and a driver 35 for the second antenna on the right. Drivers 24, 25, 34, 35 exchange signals with a controller 40. In controller 40, provision is made for an interior space logic 42 and an external space logic 44 for carrying out interior space monitoring and external space monitoring. Controller 40 exchanges signals with a memory 46 in which a current Il1 of first left antenna 21, a current Il2 of second left antenna 22, a current Ir1 of first right antenna 31, and a current Ir2 of second right antenna 33 are stored. Two opening signals 'left doors' 48, two opening signals 'right doors' 50, and an engine starting signal 52 are fed to controller 40 as further input variables.

The exemplary embodiment according to Figure 3 differs from that of Figure 2 in that left antenna array 10 is expanded by a third left antenna 23 including appertaining driver 26 for the third left antenna. Right antenna array 12 also has a third antenna 33 including appertaining driver 36. In a manner corresponding to this, a current Il3 of third left antenna 23 and a current Ir3 of third right antenna 33 are additionally stored in memory 46.

Figure 4 shows the time characteristic of a current Ir1Ar of the first right antenna for the external space interrogation on the right as well as a current Il1Ar of the first left antenna for the external space interrogation on the right. The signal patterns of these two currents are binary-inverted. The sketched rectangles (binary signal) are the envelopes of the sinusoidal current characteristic.

Left and right antenna arrays 10 and 12 are accommodated in the so-called "B-pillar" of the motor vehicle, which, in case of a four-door vehicle, is located between the two side doors. At least one antenna of the respective antenna array 10, 12 is used both for the interior space interrogation and for the external space interrogation. In the exemplary embodiment according to Figure 2, the two antennas 21, 22 or 31, 32 of each antenna array 10 or 12, respectively, are used both for the interior space and for the external space interrogations. In the exemplary embodiment according to Figure 3, it is second antennas 22 or 32 of antenna arrays 10 or 12, respectively, which are controlled both during the interior space and during the external space interrogations.

During an external space interrogation, the respective antenna arrays 10, 12 of the interrogated side and transponder 11 exchange signals. If the driver wishes to get in the vehicle, he/she operates the door handle on the left side. A corresponding opening signal 48 'left doors' activates the corresponding external space logic 44 in controller 40 for the left external space interrogation. To this end, left antenna array 10, via antenna field 16 for the external space interrogation on the left, transmits an encoded signal to transponder 11 which thereupon returns a response signal to left antenna array 10. This response is evaluated in a control unit, possibly in controller 40, and compared to a response which is considered as permissible. In case of a match, the locking system of the motor vehicle is controlled along the lines of an opening. Because of the security requirements, the

data exchange between transponder 11 and antenna arrays 10, 12 is executed in an encrypted manner, for example according to the so-called "Challenge-Response Method" or according to the "Rolling Code Method".

Since at least one antenna of antenna arrays 10, 12 is used both for the interior space and for the external space interrogations, the field distribution depicted in Figure 1 arises in response to controlling left antenna array 10 for a left external space interrogation. In this connection, antenna field 16 for the external space interrogation on the left, which is located on the left vehicle side, is desired whereas antenna field 14, which is oriented toward the interior space and which can also extend over the right vehicle side, is not desired. The intention is for the device according to the present invention to prevent antenna field 14, which is oriented toward the interior space and which emerges on the right vehicle side in this constellation, from being used for the communication with a transponder 11 located on the right vehicle side. During an external space interrogation on the left, only transponder 11 located on the left side is actually intended to bring about an access authorization but not a transponder 11 located on the right side. To achieve this, right antenna array 12 transmits an interference field 18 for the external space interrogation on the left. The generation of this interference field 18 is selected in such a manner that during the superimposition of interference field 18 and antenna field 14, which is oriented toward the interior space, a resulting field arises on the right side which no longer contains the interrogation information of left antenna array 10 for transponder 11 which is typical of the left side. The information exchanged with transponder 11 is generally binary-encoded in conjunction with a sinusoidal carrier signal of, for example, 125 kHz; also compare Figure 4. The intention is for this binary-encoded information to be interfered by interference field 18 on the right side in such a manner that, for example, a continuous field without 0/1 change arises

there. For this, it is conceivable for right antenna array 12 to be controlled in a logically inverting manner with respect to the useful signal of left antenna array 10, which is exemplarily depicted in Figure 4, so that, given a suitable selection of the coil current amplitude (current peak-peak of the carrier signal), a continuous field arises on the right side. This makes it impossible to control a transponder 11 located on the right side. To generate interference field 18, right antenna array 12 could also be controlled along the lines of noise or in a manner that it is out-of-phase relative to the current of the useful side. The current amplitudes are stored in memory 46 for each antenna and interrogation type.

At least one of the antennas of antenna arrays 10, 12 is also used for an interior space interrogation. If the user provided with a transponder 11 has obtained access to the vehicle and wishes to start the vehicle, he/she actuates a corresponding operating control element to generate engine starting signal 52. Controller 40 detects engine starting signal 52 and decides on the basis thereof to activate interior space logic 42 along the lines of the interior space interrogation. Again, antenna arrays 10, 12 carry out a signal exchange with transponder 11 located in the interior space. If transponder 11 returns a signal which is considered as valid, the user is identified as authorized to drive. The components necessary for the operation of the vehicle are released. Left and right antenna arrays 10, 12 which each cover the whole interior space are preferably controlled in succession.

In the exemplary embodiment according to Figure 2, first and second antennas 21, 31; 22, 32 are controlled both for the interior space interrogation and for the external space interrogations on the right/on the left. Consequently, three operating modes can be distinguished for each antenna. In memory 46, one current value (coil current amplitude peak-peak) is stored for each of these three operating modes, respectively. Consequently, current I11 of first left antenna

21 has three values: the current of the left first antenna for the external space interrogation on the left (Il1Al), the current of the first left antenna for the external space interrogation on the right (Il1Ar), and the current of the left first antenna for the interior space interrogation (Il1I). The equivalent applies to further antennas 22, 31, 32. During the external space interrogation on the left, the signal exchange with transponder 11 is executed, inter alia, via this first left antenna 21. Current Il1Al stored for this operating mode has a relatively high value. In the second operating mode external space interrogation on the right, first left antenna 21 generates an interference field for the external space interrogation on the right. Corresponding current value Il1Ar is to be selected to be lower than that for the external space interrogation on the left. The corresponding signal patterns for the external space interrogation on the right are depicted by way of example in Figure 4. For the third operating mode of the interior space interrogation, a current Il1I must be selected in the magnitude that the whole interior space of the motor vehicle is covered reliably.

The other current values are to be stored in a corresponding manner. For first right antenna 31, for example, the current for the external space interrogation on the left Ir1Al is to be selected to be smaller than that for the external space interrogation on the right (Ir1Ar).

In the exemplary embodiment according to Figure 3, second antenna 22 or 32, respectively, are always used both for the interior space interrogation and for the external space interrogation. Corresponding to the antennas according to Figure 2, these second antennas 22, 32, in turn, must cover three operating modes including the appertaining three current values so that for each of second antennas 22, 32, three current values (Il2Al, Il2Ar, Il2I; Ir2Al, Ir2Ar, Ir2I) are stored, respectively. First antennas 21, 31 are only used for

the external space interrogation on the right/on the left so that two current values are to be stored for this in memory 46, respectively, first, for generating a useful field, in the other case, for generating an interference field. Third antennas 23, 33, together with second antennas 22, 32, take over only the interior space interrogation. For this, only one current value (Ir3I, Il3I) is to be stored in memory 46, respectively. First antennas 21 for the external space interrogation can be air coils which, in conjunction with second antennas 22, 32, form so-called "twin-loop" antennas. First and second antennas 21 or 31 22 or 32 are respectively controlled in phase quadrature so that a rotating magnetic field arises. Ferrite coils can be used as second antennas 22, 32. The ferrite coils of second antennas 22, 32 are mounted in the B-pillars. Third antennas 23, 33 for the interior space interrogation, are also ferrite antennas and can be arranged at the floor, for example, at the drivers seat.

Figure 5 depicts the functional sequence of the operating method of a device according to the present invention. The interrogations are started, step 101, in that the controller detects a signal change of an input signal (opening signal 48/50 'left/right doors', engine starting signal 52). The three operating modes (external space interrogation on the right/on the left, interior space interrogation) are to be allocated to these input signals. During interrogation 102, it is ascertained whether the input signal producing a signal change is engine starting signal 52. In the event of an affirmative answer, controller 40 loads current values for the interior space interrogation (IlnI, IrnI) from memory 46, step 103. Index n is to be understood as sequential index; for the exemplary embodiment according to Figure 2 it applies that n=1,2; for the exemplary embodiment according to Figure 3 it applies that n=1,2,3.

Subsequently, the interior space interrogation is carried out using the values loaded from memory 46, step 104.

If the incoming signal is not engine starting signal 52, an interrogation 106 as to whether the left doors were actuated follows. If this is the case, the controller recognizes that the external space interrogation on the left is to be started. The controller loads current values for the external space interrogation on the left IlnAl, IrnAl from memory 46, step 107. If the left doors were not actuated, an actuation of the right doors is interrogated, step 109. In the event of an affirmative answer, the external space interrogation on the right is to be carried out. To this end, corresponding current values IlnAr, IrnAr are to be loaded from memory 46. The external space interrogation is carried out using current control values Iln, Irn selected in this manner, step 108. As a function of a signal change considered as permissible, either a driving authorization (during the interior space interrogation) or an access authorization (during the external space interrogation) is awarded, step 105.